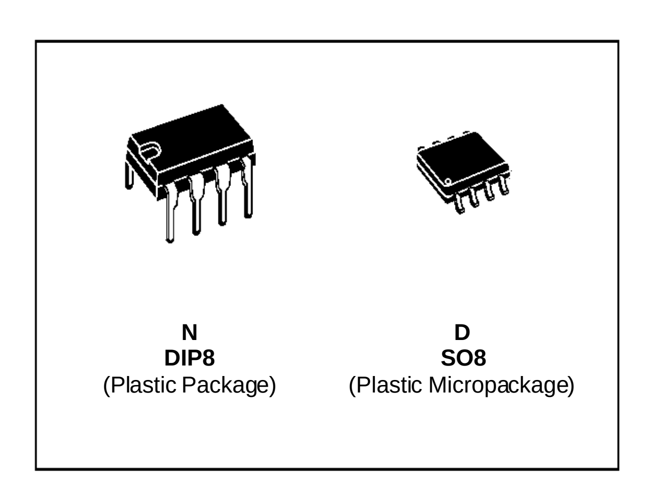


LF155-LF255-LF355
LF156-LF256-LF356
LF157-LF257-LF357

WIDE BANDWIDTH SINGLE J-FET OPERATIONAL AMPLIFIERS

- HIGH INPUT IMPEDANCE J-FET INPUT STAGE
- HIGH SPEED J-FET OP-AMPs : up to 20MHz, 50V/µs
- OFFSET VOLTAGE ADJUSTMENT DOES NOT DEGRADE DRIFT OR COMMON-MODE REJECTION AS IN MOST OF MONOLITHIC AMPLIFIERS
- INTERNAL COMPENSATION AND LARGE DIFFERENTIAL INPUT VOLTAGE CAPABILITY (UP TO V_{CC}^{+})



N
DIP8
(Plastic Package)

D
SO8
(Plastic Micropackage)

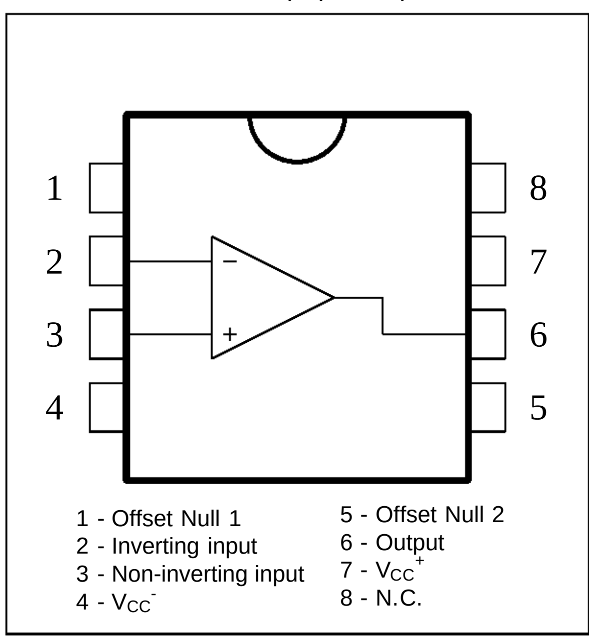
TYPICAL APPLICATIONS

- PRECISION HIGH SPEED INTEGRATORS
- FAST D/A AND CONVERTERS
- HIGH IMPEDANCE BUFFERS
- WIDEBAND, LOW NOISE, LOW DRIFT AMPLIFIERS
- LOGARITHIMIC AMPLIFIERS
- PHOTOCELL AMPLIFIERS
- SAMPLE AND HOLD CIRCUITS

ORDER CODES

Part Number	Temperature Range	Package	
		N	D
LF355, LF356, LF357	0°C, +70°C	•	•
LF255, LF256, LF257	–40°C, +105°C	•	•
LF155, LF156, LF157	–55°C, +125°C	•	•
Example : LF355N			

PIN CONNECTIONS (top view)



1 - Offset Null 1
2 - Inverting input
3 - Non-inverting input
4 - V_{CC}^{-}
5 - Offset Null 2
6 - Output
7 - V_{CC}^{+}
8 - N.C.

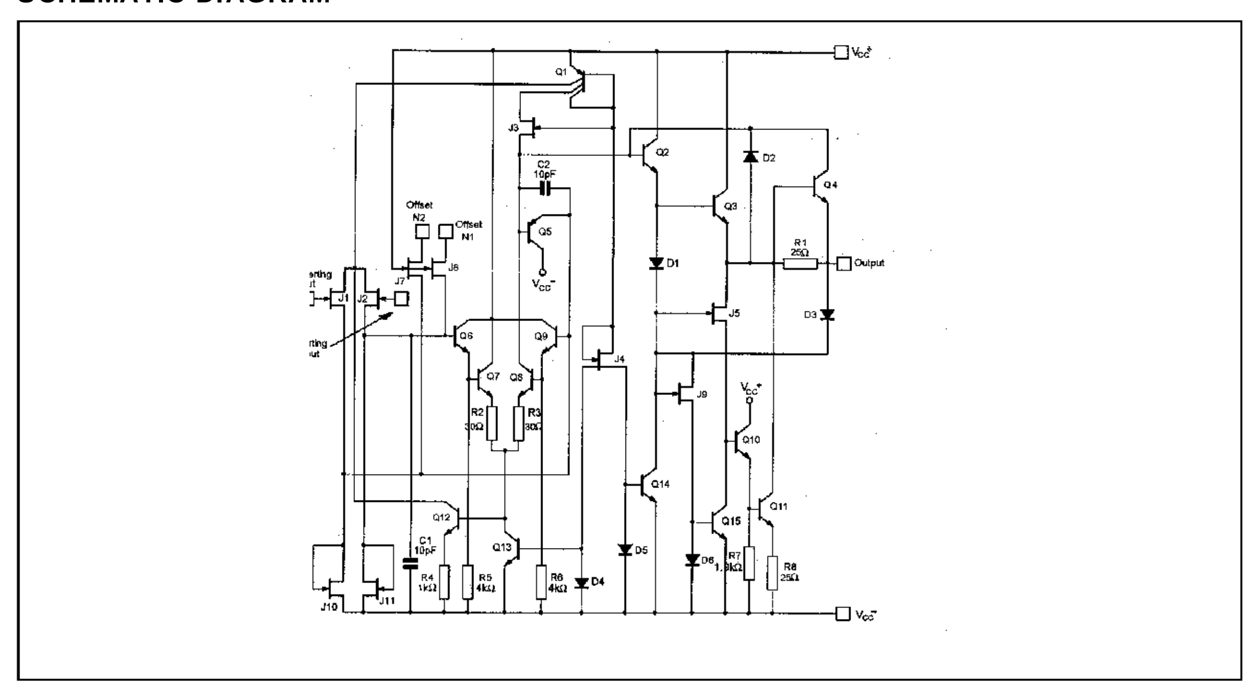
DESCRIPTION

These circuits are monolithic J-FET input operational amplifiers incorporating well matched, high voltage J-FET on the same chip with standard bipolar transistors.

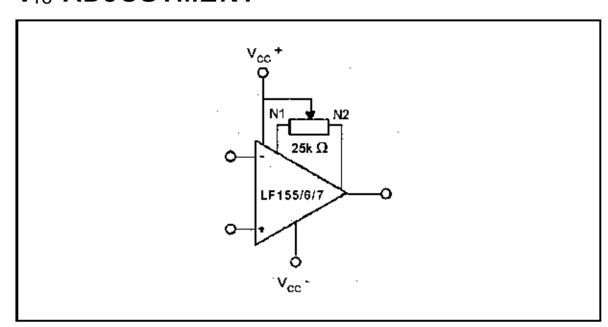
This amplifiers feature low input bias and offset currents, low input offset voltage and input offset voltage drift, coupled with offset adjust which does not degrade drift or common-mode rejection.

The devices are also designed for high slew rate, wide bandwidth, extremely fast settling time, low voltage and current noise and a low 1/f noise level.

SCHEMATIC DIAGRAM



V_{io} ADJUSTMENT



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter		Value	Unit
V_{CC}	Supply Voltage		±2	V
V_i	Input Voltage - (note 1)		±20	V
V_{id}	Differential Input Voltage		±40	V
P_{tot}	Power Dissipation		570	mW
	Output Short-circuit Duration		Infinite	
T_{oper}	Operating Free Air Temperature Range	LF155-LF156-LF157 LF255-LF256-LF257 LF355-LF356-LF357	-55 to +125 –40 to +105 0 to 70	°C
T_{stg}	Storage Temperature Range		–65 to 150	°C

ELECTRICAL CHARACTERISTICS

LF155, LF156, LF157 $-55^oC \leq T_{amb} \leq +125^oC$ $\pm5V \leq V_{CC} \leq \pm20V$

LF255, LF256, LF257 $-40^oC \leq T_{amb} \leq +105^oC$ $\pm5V \leq V_{CC} \leq \pm20V$

(unless otherwise specified)

Symbol	Parameter	LF155 - LF156 - LF157 LF255 - LF256 - LF257			Unit
		Min.	Typ.	Max.	
V_{io}	Input Offset Voltage ($R_S = 50\Omega$) $T_{amb} = 25^oC$ $T_{min.} \leq T_{amb} \leq T_{max.}$ LF155, LF156, LF157 LF255, LF256, LF257		 3	 5 7 6.2	mV
I_{io}	Input Offset Current - (note 3) $T_{amb} = 25^oC$ $T_{min.} \leq T_{amb} \leq T_{max.}$ LF155, LF156, LF157 LF255, LF256, LF257		 3	 20 20 1	 pA nA nA
I_{ib}	Input Bias Current - (note 3) $T_{amb} = 25^oC$ $T_{min.} \leq T_{amb} \leq T_{max.}$ LF155, LF156, LF157 LF255, LF256, LF257		 20	 100 50 5	 pA nA nA
A_{vd}	Large Signal Voltage Gain ($R_L = 2k\Omega$, $V_O = \pm10V$, $V_{CC} = \pm15V$) $T_{amb} = 25^oC$ $T_{min.} \leq T_{amb} \leq T_{max.}$	 50 25	 200		V/mV
SVR	Supply Voltage Rejection Ratio - (note 4)	85	100		dB
I_{CC}	Supply Current ($V_{CC} = \pm15V$, no load) $T_{amb} = 25^oC$ LF155, LF255 LF156, LF256 LF157, LF257		 2 5 5	 4 7 7	mA
DV_{io}	Input Offset Voltage Drift ($R_S = 50\Omega$)		5		$\mu V/^oC$
DV_{io}/V_{io}	Change in Average Temperature Coefficient with V_{io} adjust ($R_S = 50\Omega$) - (note 2)		0.5		$\mu V/^oC$
V_{icm}	Input Common Mode Voltage Range ($V_{CC} = \pm15V$, $T_{amb} = 25^oC$)	±11	+15.1 -12		V
CMR	Common Mode Rejection Ratio	85	100		dB
$\pm V_{OPP}$	Output Voltage Swing ($V_{CC} = \pm15V$) $R_L = 10k\Omega$ $R_L = 2k\Omega$	 ±12 ±10	 ±13 ±12		V
GBP	Gain Bandwidth Product ($V_{CC} = \pm15V$, $T_{amb} = 25^oC$) LF155, LF255 LF156, LF256 LF157, LF257		 2.5 5 20		MHz
SR	Slew Rate ($V_{CC} = \pm15V$, $T_{amb} = 25^oC$) $A_V = 1$ LF155, LF255 LF156, LF256 $A_V = 5$ LF157, LF257	 7.5 30	 5 12 50		V/µs
R_i	Input Resistance ($T_{amb} = 25^oC$)		10^{12}		Ω
C_i	Input Capacitance ($V_{CC} = \pm15V$, $T_{amb} = 25^oC$)		3		pF
e_n	Equivalent Input Noise Voltage ($V_{CC} = \pm15V$, $T_{amb} = 25^oC$, $R_S = 100\Omega$) f = 1000Hz LF155, LF255 LF156, LF256 LF157, LF257 f = 100Hz LF155, LF255 LF156, LF256 LF157, LF257		 20 12 12 25 15 15		$\frac{nV}{\sqrt{Hz}}$
i_n	Equivalent Input Noise Current ($V_{CC} = \pm15V$, $T_{amb} = 25^oC$, f = 100Hz or f = 1000Hz)		0.01		$\frac{pA}{\sqrt{Hz}}$
t_s	Settling Time ($V_{CC} = \pm15V$, $T_{amb} = 25^oC$) - (note 5) LF155, LF255 LF156, LF256 LF157, LF257		 4 1.5 1.5		µs

ELECTRICAL CHARACTERISTICS

LF355, LF356, LF357 $0^oC \leq T_{amb} \leq +70^oC$ $V_{CC} = \pm15V$, (unless otherwise specified)

Symbol	Parameter		LF355 - LF356 - LF357			Unit
			Min.	Typ.	Max.	
V_{io}	Input Offset Voltage ($R_S = 50\Omega$) $T_{amb} = 25^oC$ $T_{min.} \leq T_{amb} \leq T_{max.}$			3	10 13	mV
I_{io}	Input Offset Current - (note 3) $T_{amb} = 25^oC$ $T_{min.} \leq T_{amb} \leq T_{max.}$			3	50 2	pA nA
I_{ib}	Input Bias Current - (note 3) $T_{amb} = 25^oC$ $T_{min.} \leq T_{amb} \leq T_{max.}$			20	200 8	pA nA
A_{vd}	Large Signal Voltage Gain ($R_L = 2k\Omega$, $V_O = \pm10V$) $T_{amb} = 25^oC$ $T_{min.} \leq T_{amb} \leq T_{max.}$		25 15	200		V/mV
SVR	Supply Voltage Rejection Ratio - (note 4)		80	100		dB
I_{CC}	Supply Current (no load) $T_{amb} = 25^oC$	LF355 LF356, LF357		2 5	4 10	mA
DV_{io}	Input Offset Voltage Drift ($R_S = 50\Omega$) - (note 2)			5		$\mu V/^oC$
DV_{io}/V_{io}	Change in Average Temperature Coefficient with V_{io} adjust ($R_S = 50\Omega$)			0.5		$\mu V/^oC$ per mV
V_{icm}	Input Common Mode Voltage Range ($T_{amb} = 25^oC$)		±10	+15.1 -12		V
CMR	Common Mode Rejection Ratio		80	100		dB
$\pm V_{OPP}$	Output Voltage Swing	$R_L = 10k\Omega$ $R_L = 2k\Omega$	±12 ±10	±13 ±12		V
GBP	Gain Bandwidth Product $T_{amb} = 25^oC$)	LF355 LF356 LF357		2.5 5 20		MHz
SR	Slew Rate ($T_{amb} = 25^oC$) $A_V = 1$ $A_V = 5$	LF355 LF356 LF357		5 12 50		V/µs
R_i	Input Resistance ($T_{amb} = 25^oC$)			10^{12}		Ω
C_i	Input Capacitance (Tamb = 25^oC)			3		pF
e_n	Equivalent Input Noise Voltage ($T_{amb} = 25^oC$, $R_S = 100\Omega$) f = 1000Hz f = 100Hz	LF355 LF356, LF357 LF355 LF356, LF357		20 12 25 15		$\frac{nV}{\sqrt{Hz}}$
i_n	Equivalent Input Noise Current ($T_{amb} = 25^oC$, f = 100Hz or f = 1000Hz)			0.01		$\frac{pA}{\sqrt{Hz}}$
t_s	Settling Time ($T_{amb} = 25^oC$) - (note 5)	LF355 LF356, LF357		4 1.5		µs

Notes :
1. Unless otherwise specified the absolute maximum negative input voltage is equal to the negative power supply voltage.
2. The temperature coefficient of the adjusted input offset voltage changes only a small amount (0.5µV/°C typically) for each mV of adjustment from its original unadjusted value. Common-mode rejection and open loop voltage gain are alsounaffected by offset adjustment.
3. The input bias currents are junction leakage currents which approximately double for every 10°C increase in the junction temperature T_{amb}. Due to limited production test time, the input bias current measured is correlated to junction temperature. In a normal operation the junction temperature rises above the ambient temperature as a result of internal power dissipation, P_{tot}-T_{amb} =T_{amb}+$R_{th(j-a)}$xP_{tot} where $Rt_{h(j-a)}$ is the thermal resistance from junction to ambient. Use of a heatsink is recommended f input currents are to be kept to a minimum.
4. Supply voltage rejection is measured for both supply magnitudes increasing or decreasing simultaneously, in accordance with common practise.
5. Settling time is defined here, for a unity gain inverter connection using 2kΩ resistors for the LF155, LF156 series. It is the time required for the error voltage (the voltage at the inverting input pin on the amplifier) to settle to within 0.01% of its final value from the time a 10V step input is applied to the inverter. For the LF157 series A_V = -5, the feedback resistor from output to input is 2kΩ and the output step is 10V.

APPLICATION HINTS

The LF155, LF156, LF157 series are op amps with J-FETinput transistors. TheseJFETs havelarge reverse breakdown voltagesfromgatetosource or drain eliminatingtheneed of clamps across the inputs.Therefore large differential input voltages can easily be accommodatedwithoutalarge increaseof inputcurrents.The maximum differential input voltage is independent of the supply voltage. However, neitherof thenegative input voltagesshould be allowed to exceedthe negative supply as this will cause large currents to flow which can result in a destroyed unit. Exceeding the negative common-mode limit on either inputwill causeareversal of thephasetotheoutputandforce the amplifier output to the correspondinghigh or lowstate. Exceedingthe negativecommon-mode limit on bothinputs will force the amplifier outputto a high state. In neither case does a latch occur since raising the input back within the common-mode range again puts the input stage and thusthe amplifier in a normal operating mode. Exceedingthepositive common-modelimit on asingle input will not changethephase of the output however, if bothinputsexceedthe limit, theoutput of theamplifier will be forcedtoahighstate.Theseamplifiers will operatewith the common-mode input voltage equal to the positive supply. In fact, the common-modevoltagecanexceedthepositivesupplyby approximately 100mV independentof supply volt-age and over thefull operatingtemperaturerange.The positive suplly can thereforebe used as a referenceon aninput as, forexample, in a supply current monitor and/or limiter. Precautionsshould be taken to ensurethat thepowersupply forthe integrated circuit never becomes re-versed in polarity or that the unit is not inadvertentlyin-stalled backwards in a socket as an unilimited current surge throughthe resulting forward diode within the IC couldcausefusingoftheinternalconductorsandresultin a destroyedunit.

Because these amplifiers are JFET rather than MOS-FET input op amps they do not require special handling.

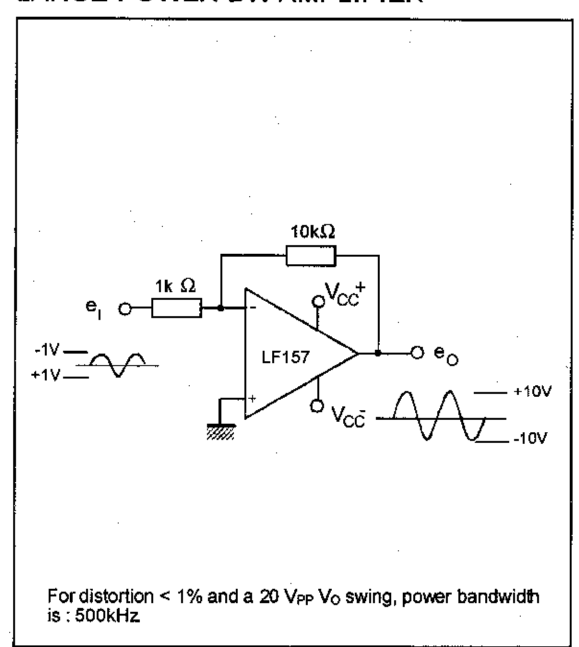
Allof thebias currents in theseamplifiersareset by FET current sources. The drain currents for the amplifiers are therefore essentially independent of supply voltages.

As with most amplifiers, care should betaken with lead dress, components placement and supply decoupling in order to ensure stability. For example, resistors from the output to an input should be placed with the body close to theinput to minimiz "pickup" and maximize the frequency of the feedback pole by minimizing the capacitancefrom the input to ground.

A feedback pole is createdwhen the feedbackaround any amplifier is resistive. The parallel resistance and capacitancefromthe input of thedevice(usually the invertinginput)toacgroundsetthefrequencyofthepole.In many instances the frequency of this pole is much greaterthanthe expected3 dBfrequencyof the closed loopgain and consequentlythereisnegligible effect on stability margin. However, if the feedback pole is less than approximately six time the expected 3 dB frequencya leadcapacitor should be placed from the output to the input of the op amp. The value of that added capacitor should be such that the RC time constant of this capacitor and the resistance it parallels is greater than or equal to the original feedback pole time constant.

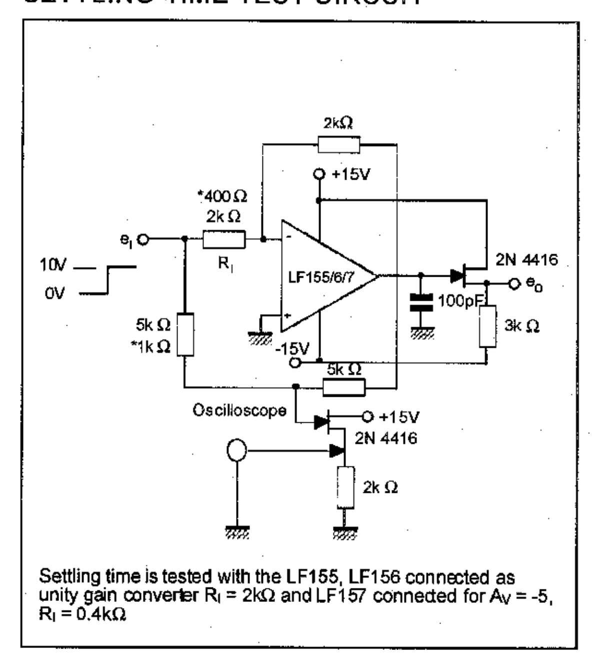
TYPICAL CIRCUITS

LARGE POWER BW AMPLIFIER

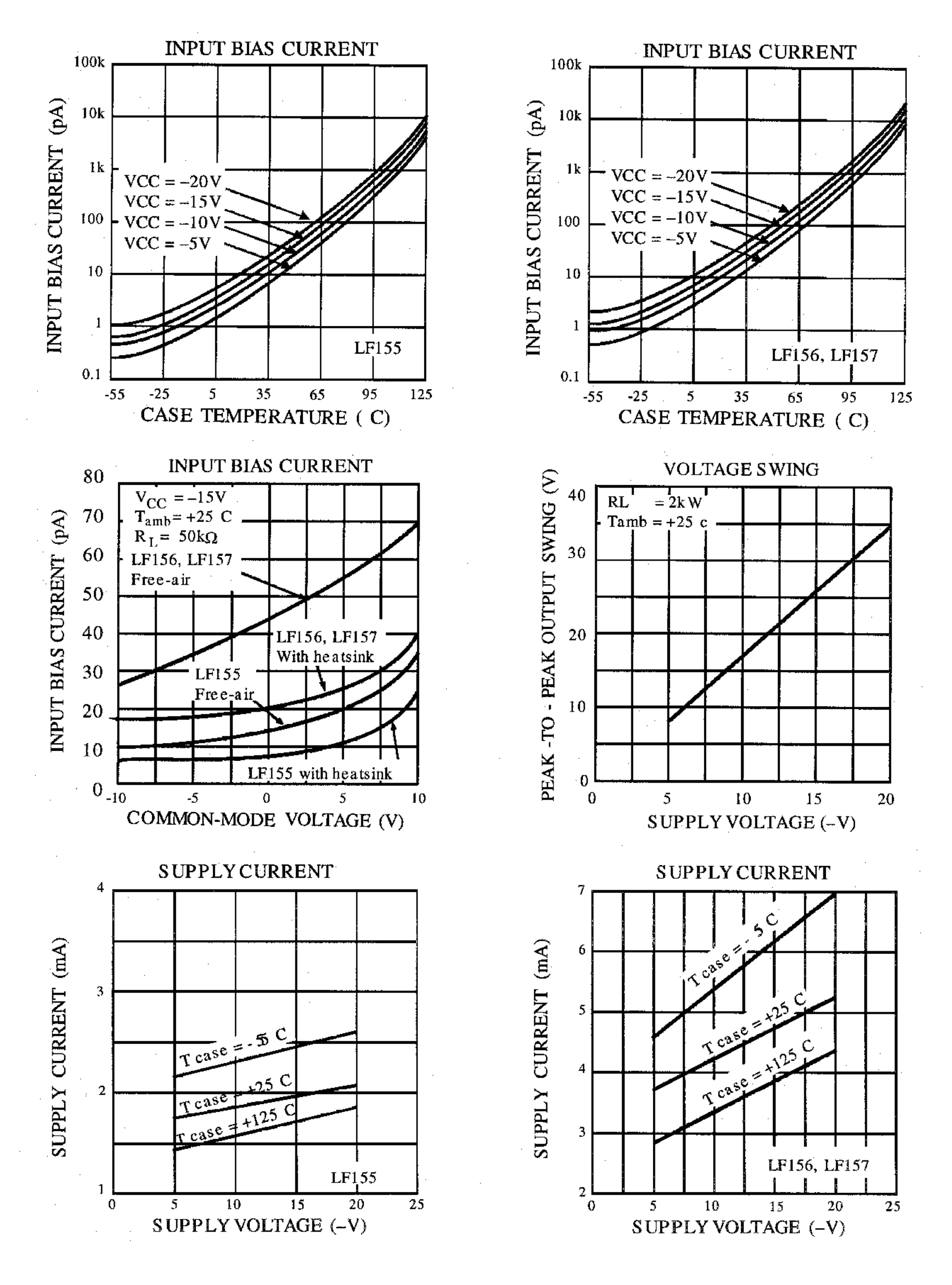


For distortion < 1% and a 20 V_{PP} V_O swing, power bandwidth is : 500kHz

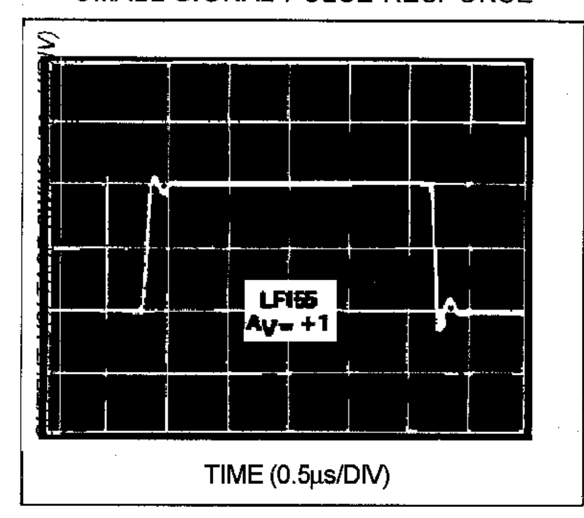
SETTLING TIME TEST CIRCUIT



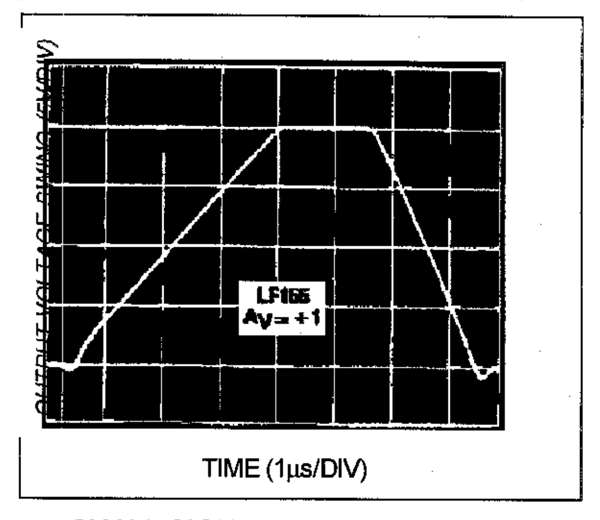
Settling time is tested with the LF155, LF156 connected as unity gain converter R_I = 2kΩ and LF157 connected for A_V = -5, R_I = 0.4kΩ


INPUT BIAS CURRENT
INPUT BIAS CURRENT (pA)
VCC = –20V
VCC = –15V
VCC = –10V
VCC = –5V
LF155
CASE TEMPERATURE (C)
INPUT BIAS CURRENT
INPUT BIAS CURRENT (pA)
VCC = –20V
VCC = –15V
VCC = –10V
VCC = –5V
LF156, LF157
CASE TEMPERATURE (C)
INPUT BIAS CURRENT
INPUT BIAS CURRENT (pA)
VCC = –15V
Tamb = +25 C
RL = 50kΩ
LF156, LF157
Free-air
LF156, LF157
With heatsink
LF155
Free-air
LF155 with heatsink
COMMON-MODE VOLTAGE (V)
VOLTAGE SWING
PEAK -TO - PEAK OUTPUT SWING (V)
RL = 2kW
Tamb = +25 c
SUPPLY VOLTAGE (–V)
SUPPLY CURRENT
SUPPLY CURRENT (mA)
T case = - 55 C
T case = +25 C
T case = +125 C
LF155
SUPPLY VOLTAGE (–V)
SUPPLY CURRENT
SUPPLY CURRENT (mA)
T case = - 55 C
T case = +25 C
T case = +125 C
LF156, LF157
SUPPLY VOLTAGE (–V)

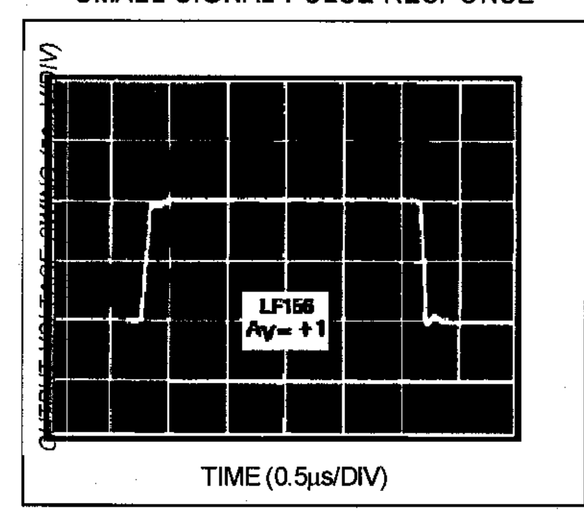
SMALL SIGNAL PULSE RESPONSE



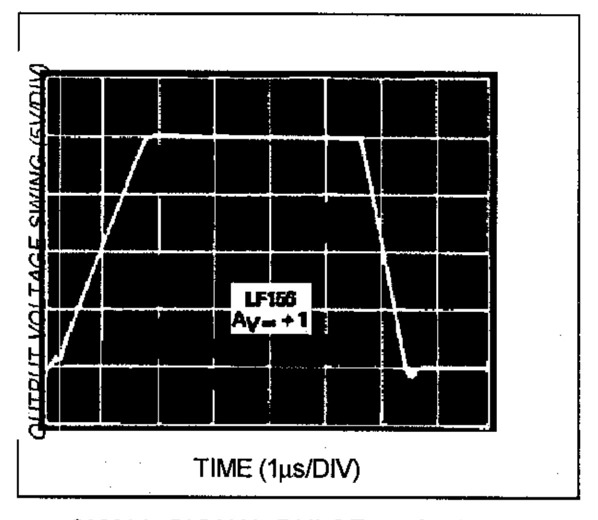
SMALL SIGNAL PULSE RESPONSE



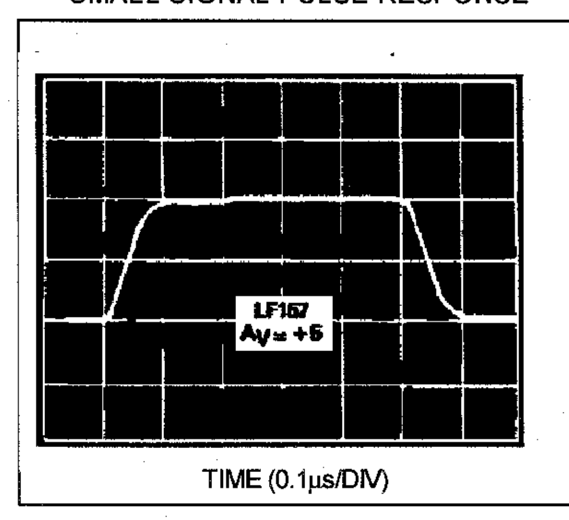
SMALL SIGNAL PULSE RESPONSE



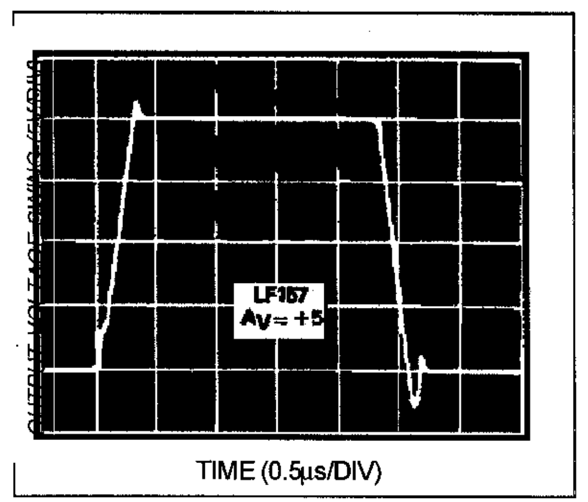
SMALL SIGNAL PULSE RESPONSE

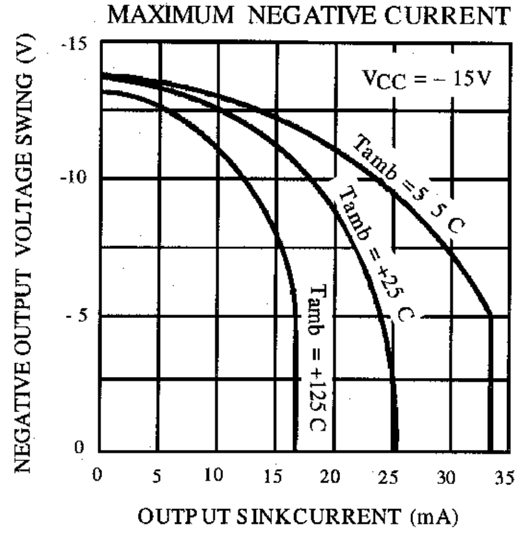


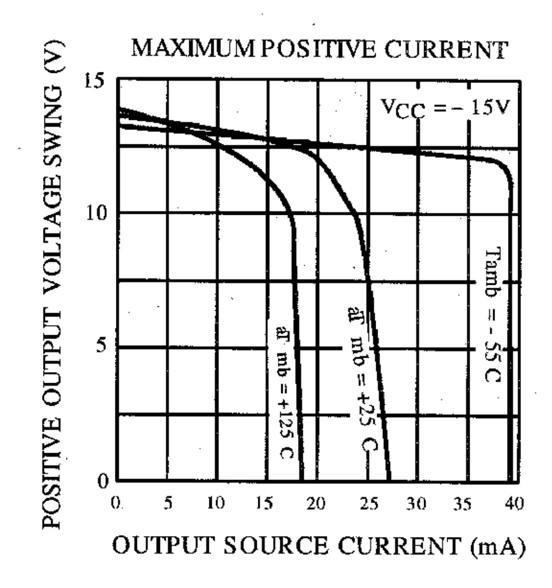
SMALL SIGNAL PULSE RESPONSE

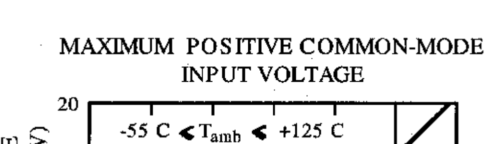


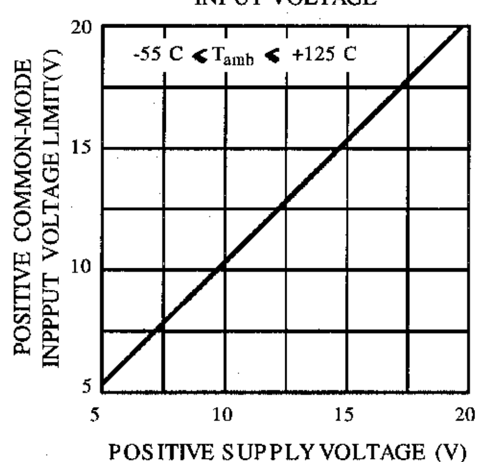
SMALL SIGNAL PULSE RESPONSE



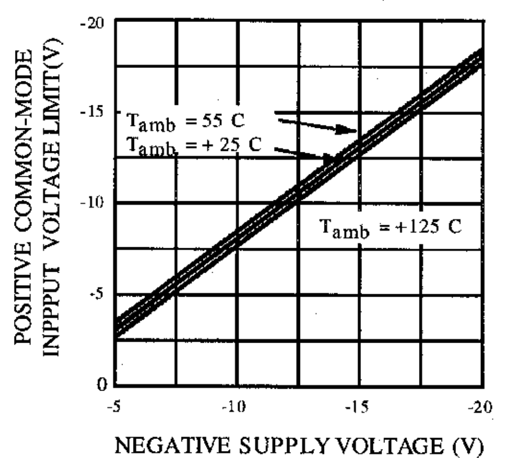

MAXIMUM NEGATIVE CURRENT
VCC = – 15V
Tamb = 5 5 C
Tamb = +25 C
Tamb = +125 C
NEGATIVE OUTPUT VOLTAGE SWING (V)
OUTPUT SINKCURRENT (mA)

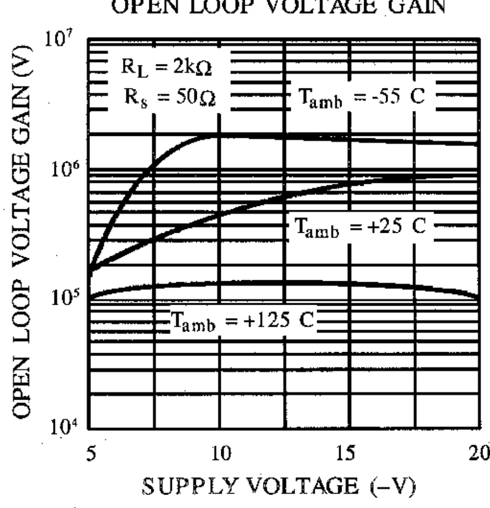

MAXIMUM POSITIVE CURRENT
VCC = – 15V
Tamb = - 55 C
Tamb = +25 C
Tamb = +125 C
POSITIVE OUTPUT VOLTAGE SWING (V)
OUTPUT SOURCE CURRENT (mA)

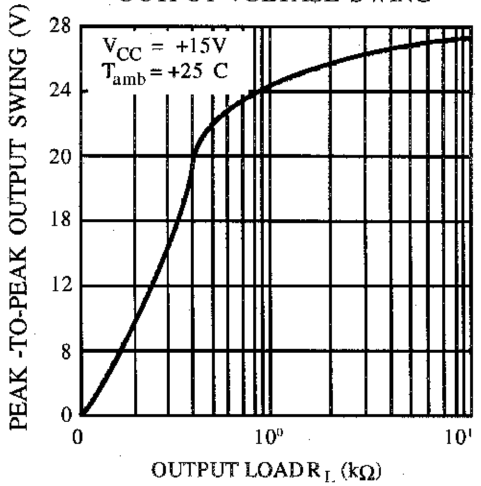

MAXIMUM POSITIVE COMMON-MODE
INPUT VOLTAGE

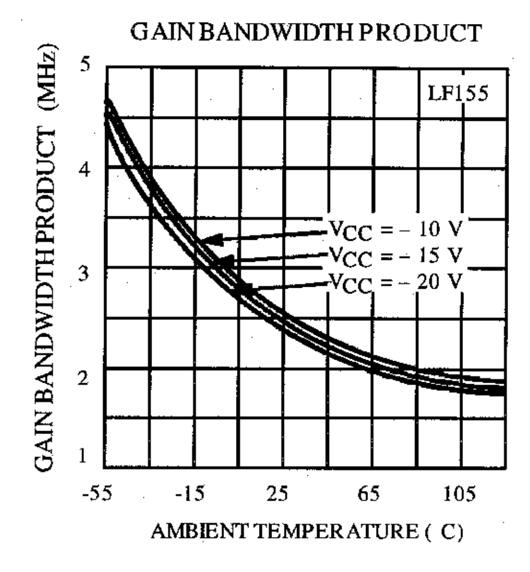

-55 C < Tamb < +125 C
POSITIVE COMMON-MODE
INPPPUT VOLTAGE LIMIT(V)

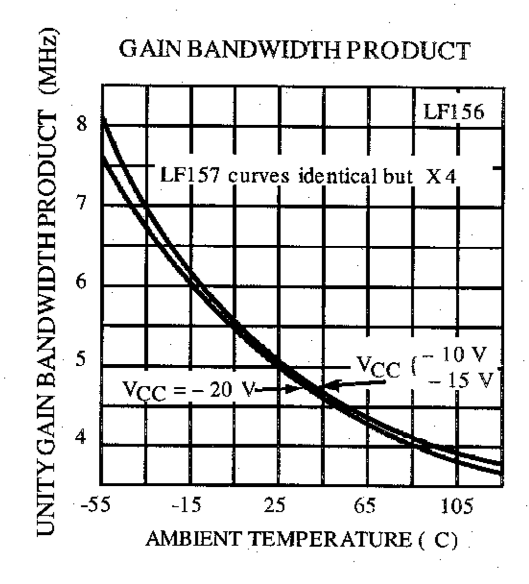

POSITIVE SUPPLY VOLTAGE (V)

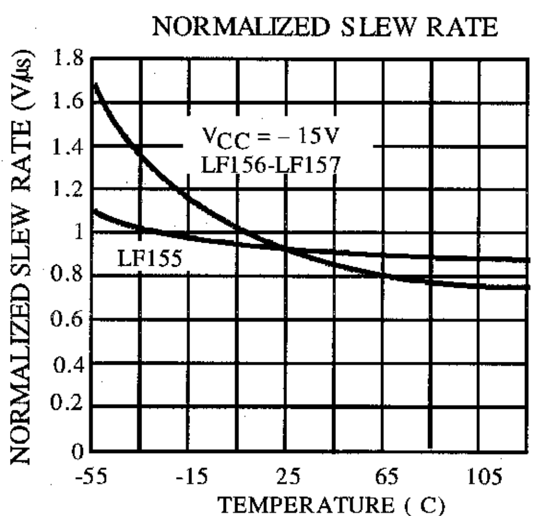

MAXIMUM NEGATIVE COMMON-MODE
INPUT VOLTAGE
Tamb = 55 C
Tamb = + 25 C
Tamb = +125 C
POSITIVE COMMON-MODE
INPPPUT VOLTAGE LIMIT(V)
NEGATIVE SUPPLY VOLTAGE (V)

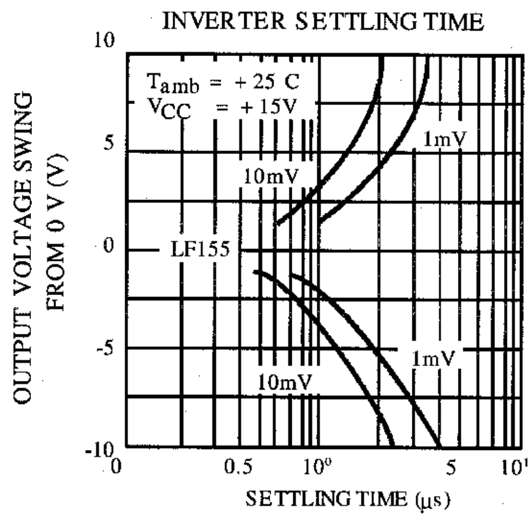

OPEN LOOP VOLTAGE GAIN
RL = 2kΩ
Rs = 50Ω
Tamb = -55 C
Tamb = +25 C
Tamb = +125 C
OPEN LOOP VOLTAGE GAIN (V)
SUPPLY VOLTAGE (–V)

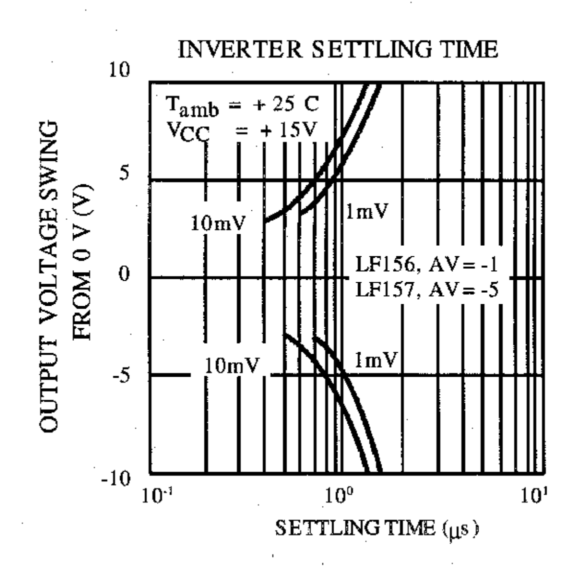

OUTPUT VOLTAGE SWING
VCC = +15V
Tamb = +25 C
PEAK -TO-PEAK OUTPUT SWING (V)
OUTPUT LOAD RL (kΩ)

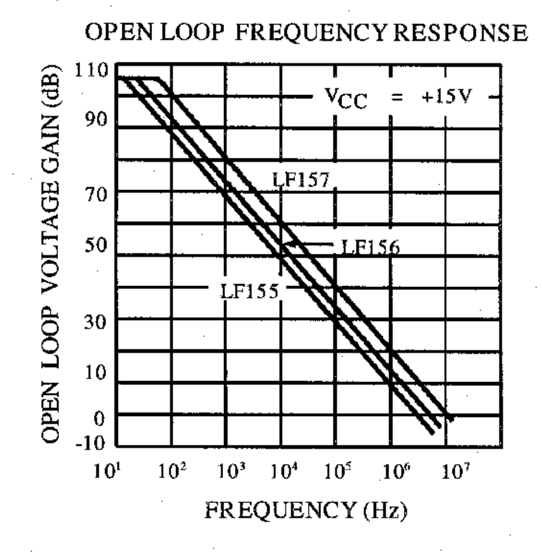

GAIN BANDWIDTH PRODUCT
GAIN BANDWIDTH PRODUCT (MHz)
LF155
VCC = ± 10 V
VCC = ± 15 V
VCC = ± 20 V
AMBIENT TEMPERATURE (C)

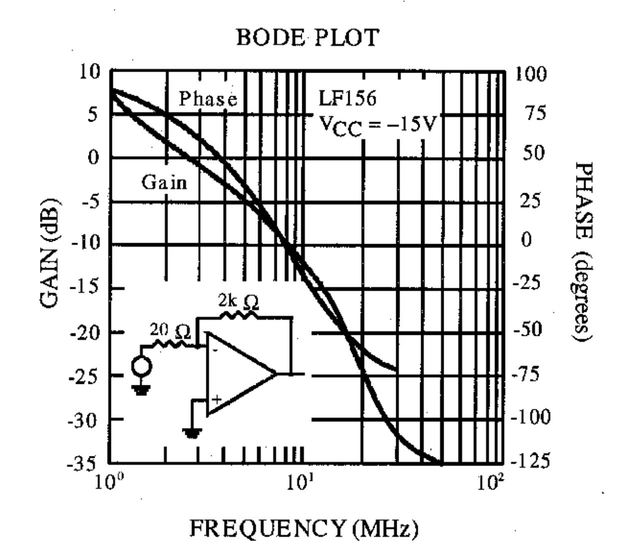

GAIN BANDWIDTH PRODUCT
UNITY GAIN BANDWIDTH PRODUCT (MHz)
LF156
LF157 curves identical but X 4
VCC = ± 20 V
VCC (± 10 V
± 15 V
AMBIENT TEMPERATURE (C)

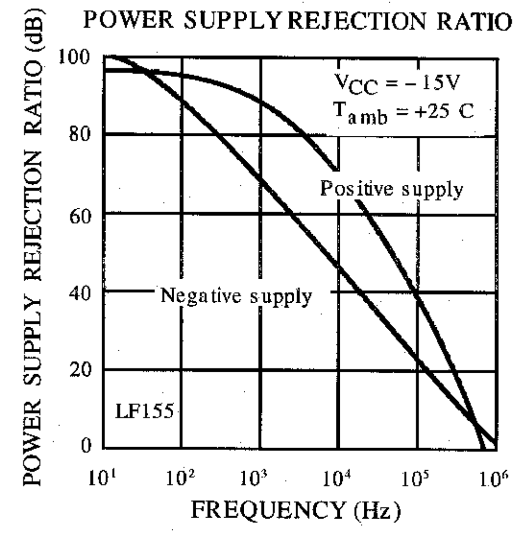

NORMALIZED SLEW RATE
NORMALIZED SLEW RATE (V/µs)
VCC = ± 15V
LF156-LF157
LF155
TEMPERATURE (C)

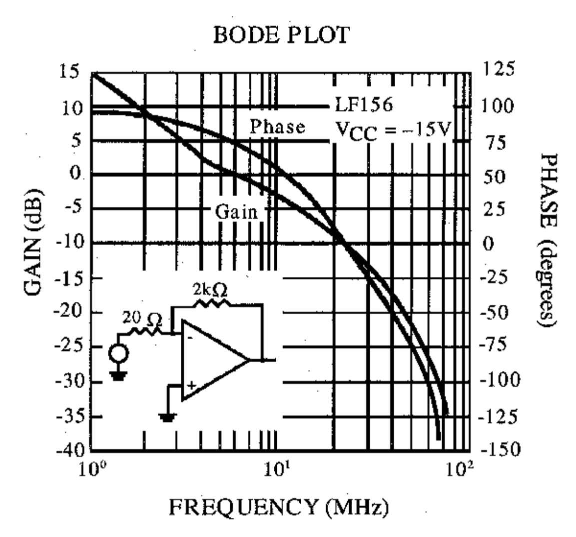

INVERTER SETTLING TIME
OUTPUT VOLTAGE SWING
FROM 0 V (V)
Tamb = + 25 C
VCC = ± 15V
10mV
1mV
LF155
SETTLING TIME (µs)

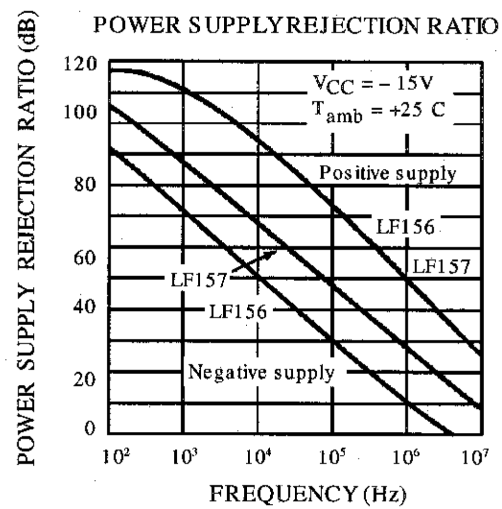

INVERTER SETTLING TIME
OUTPUT VOLTAGE SWING
FROM 0 V (V)
Tamb = + 25 C
VCC = ± 15V
10mV
1mV
LF156, AV= -1
LF157, AV= -5
SETTLING TIME (µs)

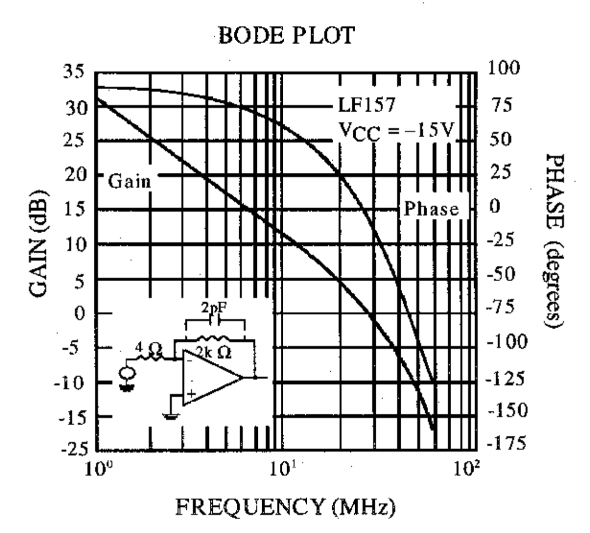

OPEN LOOP FREQUENCY RESPONSE
OPEN LOOP VOLTAGE GAIN (dB)
VCC = ±15V
LF157
LF156
LF155
FREQUENCY (Hz)

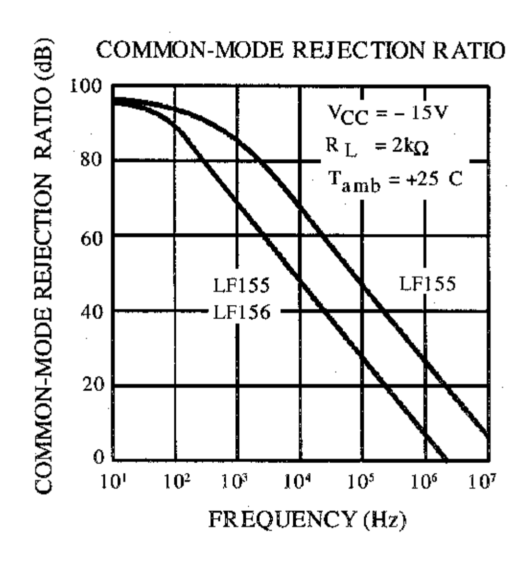

BODE PLOT
Phase
LF156
V_{CC} = –15V
Gain
2k Ω
20 Ω
GAIN (dB)
PHASE (degrees)
FREQUENCY (MHz)

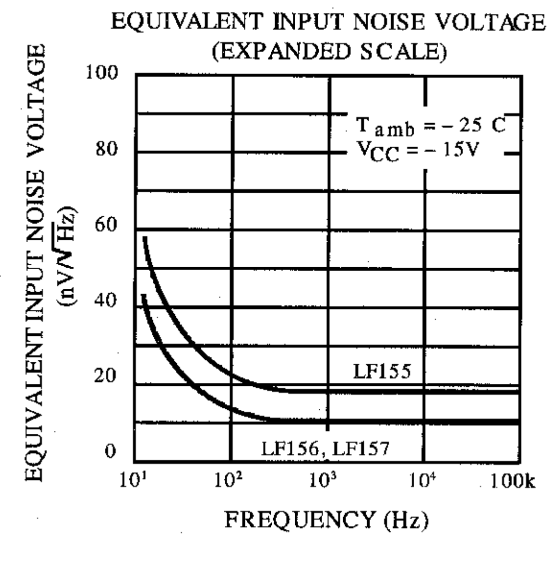

POWER SUPPLY REJECTION RATIO
V_{CC} = – 15V
T_{amb} = +25 C
Positive supply
Negative supply
LF155
POWER SUPPLY REJECTION RATIO (dB)
FREQUENCY (Hz)

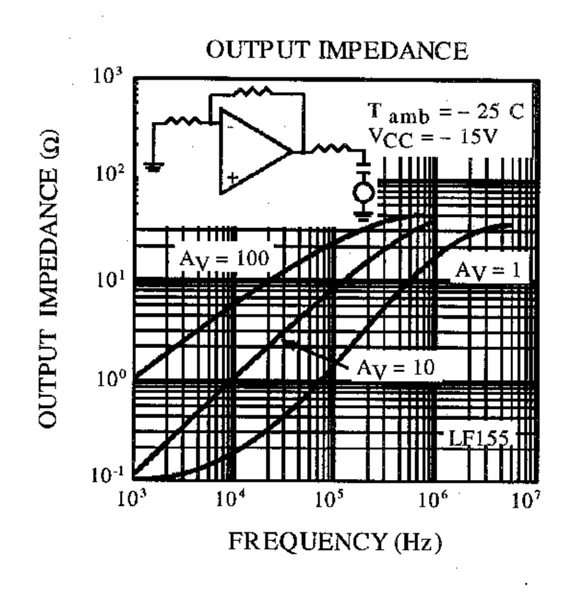

BODE PLOT
LF156
V_{CC} = –15V
Phase
Gain
2kΩ
20 Ω
GAIN (dB)
PHASE (degrees)
FREQUENCY (MHz)

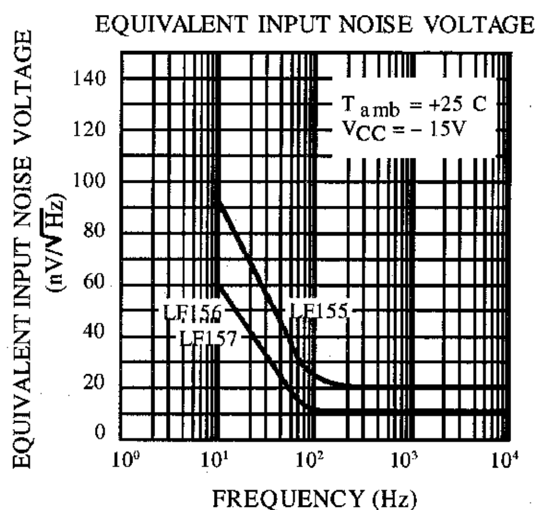

POWER SUPPLY REJECTION RATIO
V_{CC} = – 15V
T_{amb} = +25 C
Positive supply
LF156
LF157
LF157
LF156
Negative supply
POWER SUPPLY REJECTION RATIO (dB)
FREQUENCY (Hz)

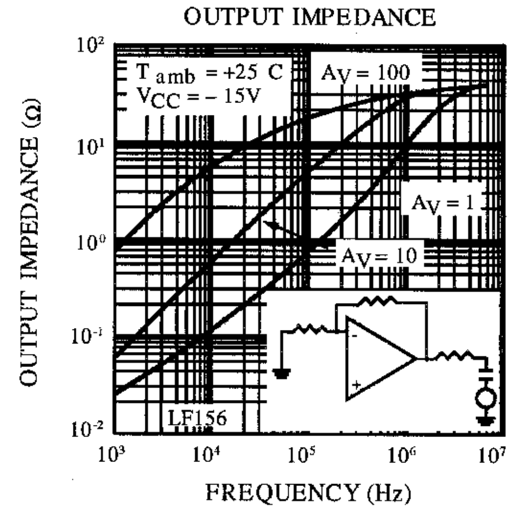

BODE PLOT
LF157
V_{CC} = –15V
Gain
Phase
2pF
2k Ω
4 Ω
GAIN (dB)
PHASE (degrees)
FREQUENCY (MHz)

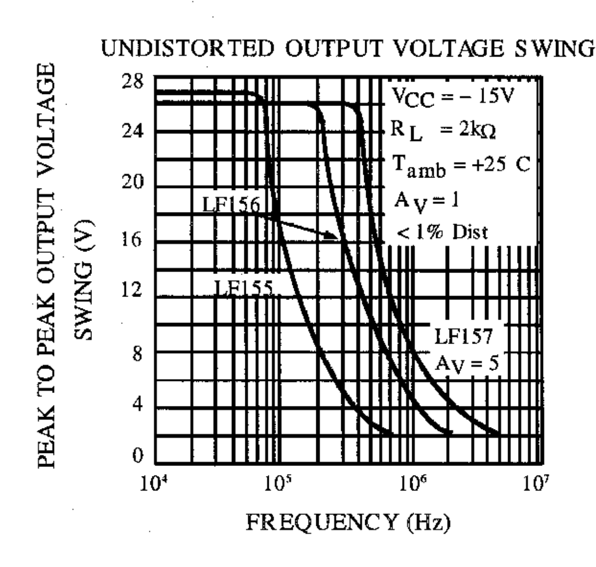

COMMON-MODE REJECTION RATIO
V_{CC} = – 15V
R_L = 2kΩ
T_{amb} = +25 C
LF155
LF156
LF155
COMMON-MODE REJECTION RATIO (dB)
FREQUENCY (Hz)

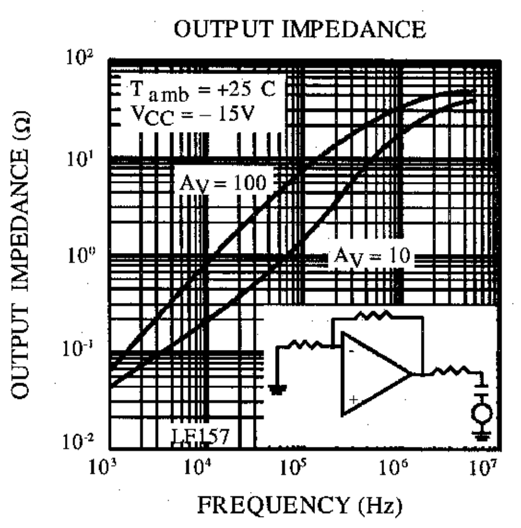

EQUIVALENT INPUT NOISE VOLTAGE
(EXPANDED SCALE)
EQUIVALENT INPUT NOISE VOLTAGE (nV/√Hz)
T amb = – 25 C
VCC = – 15V
LF155
LF156, LF157
FREQUENCY (Hz)


OUTPUT IMPEDANCE
OUTPUT IMPEDANCE (Ω)
T amb = – 25 C
VCC = – 15V
AV = 100
AV = 1
AV = 10
LF155
FREQUENCY (Hz)


EQUIVALENT INPUT NOISE VOLTAGE
EQUIVALENT INPUT NOISE VOLTAGE (nV/√Hz)
T amb = +25 C
VCC = – 15V
LF156
LF157
LF155
FREQUENCY (Hz)

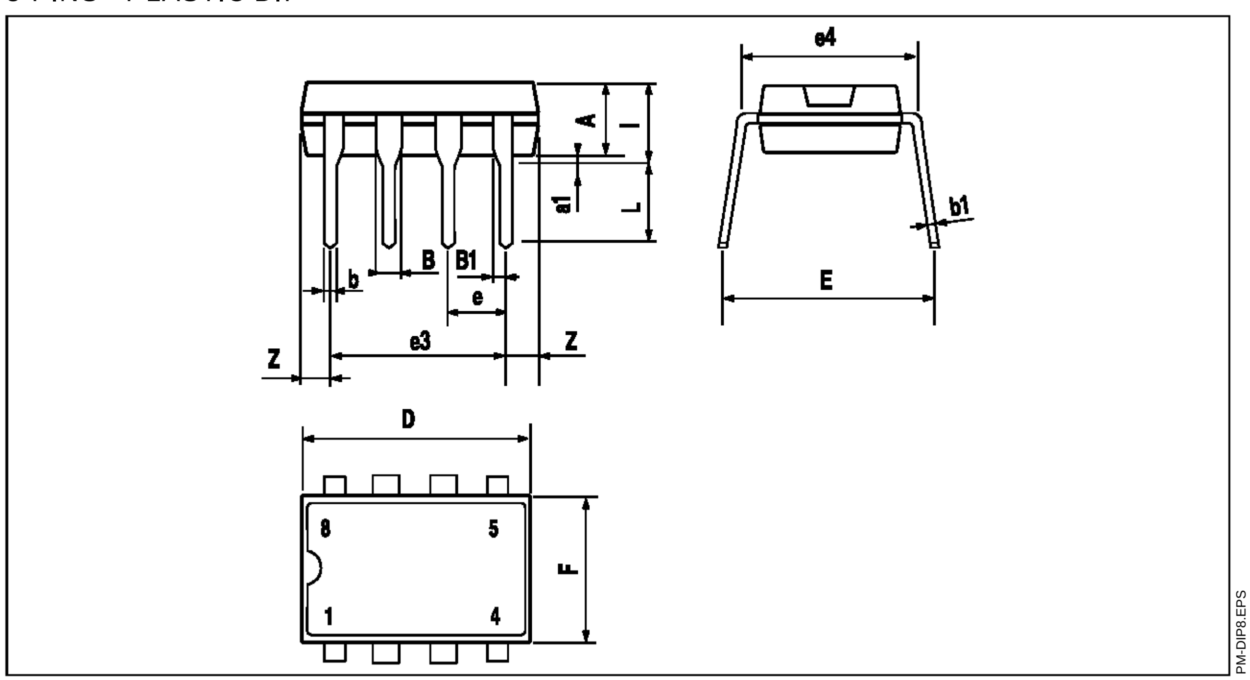

OUTPUT IMPEDANCE
OUTPUT IMPEDANCE (Ω)
T amb = +25 C
VCC = – 15V
AV = 100
AV = 1
AV = 10
LF156
FREQUENCY (Hz)


UNDISTORTED OUTPUT VOLTAGE SWING
PEAK TO PEAK OUTPUT VOLTAGE SWING (V)
VCC = – 15V
RL = 2kΩ
Tamb = +25 C
AV = 1
< 1% Dist
LF156
LF155
LF157
AV = 5
FREQUENCY (Hz)


OUTPUT IMPEDANCE
OUTPUT IMPEDANCE (Ω)
T amb = +25 C
VCC = – 15V
AV = 100
AV = 10
LF157
FREQUENCY (Hz)

PACKAGE MECHANICAL DATA

8 PINS - PLASTIC DIP

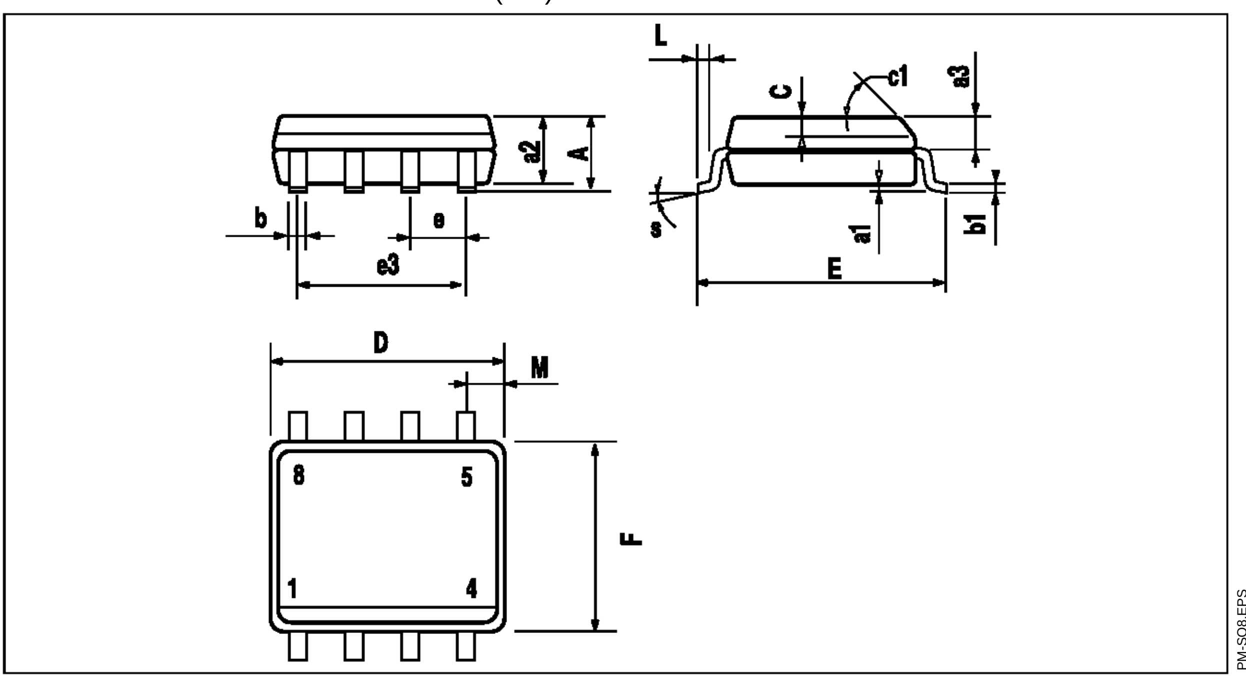


Dimensions	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A		3.32			0.131	
a1	0.51			0.020		
B	1.15		1.65	0.045		0.065
b	0.356		0.55	0.014		0.022
b1	0.204		0.304	0.008		0.012
D			10.92			0.430
E	7.95		9.75	0.313		0.384
e		2.54			0.100	
e3		7.62			0.300	
e4		7.62			0.300	
F			6.6			0260
i			5.08			0.200
L	3.18		3.81	0.125		0.150
Z			1.52			0.060

DIP8.TBL

PACKAGE MECHANICAL DATA

8 PINS - PLASTIC MICROPACKAGE (SO)



Dimensions	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
a1	0.1		0.25	0.004		0.010
a2			1.65			0.065
a3	0.65		0.85	0.026		0.033
b	0.35		0.48	0.014		0.019
b1	0.19		0.25	0.007		0.010
C	0.25		0.5	0.010		0.020
c1	45° (typ.)					
D	4.8		5.0	0.189		0.197
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		3.81			0.150	
F	3.8		4.0	0.150		0.157
L	0.4		1.27	0.016		0.050
M			0.6			0.024
S	8° (max.)					

SO8.TBL